Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	991	(front adj side) and (back adj side) and (wafer or substrate) and (inspect ot inspecting or inspection)	US-PGPUB; USPAT	OR	ON	2005/03/11 11:57
L2	860	1 and (defects or contaminations or damage or particles or residual or residues or fibers or scratches or breakage)	US-PGPUB; USPAT	OR	ON	2005/03/11 11:51
L3	83	2 and (correlating or correlation)	US-PGPUB; USPAT	OR	ON	2005/03/11 12:07
L4	49	3 and @ad<"20021004"	US-PGPUB; USPAT	OR	ON	2005/03/11 11:59
L5	26	(front adj side) same (back adj side) same (correlation or correlating)	US-PGPUB; USPAT	OR	ON	2005/03/11 12:02
L6	16	5 and @ad<"20021004"	US-PGPUB; USPAT	OR	ON	2005/03/11 12:07
L7	16	6 not 4	US-PGPUB; USPAT	OR	ON	2005/03/11 11:59
L8	20	(front adj side) same (back adj side) same (correlation or correlating)	USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2005/03/11 12:02
L9	2	(front adj side) same (back adj side) same (correlation or correlating) same (wafer or substrate)	US-PGPUB; USPAT	OR	ON	2005/03/11 12:07
L10	2	(front adj side) same (back adj side) same (correlation or correlating) same (wafer or substrate)	USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2005/03/11 12:05
L11	3307	((front adj side) same (back adj side)) same (wafer or substrate)	US-PGPUB; USPAT	OR	ON	2005/03/11 12:07
L12	144	11 and (correlating or correlation)	US-PGPUB; USPAT	OR	ON	2005/03/11 12:07
L13	113	12 and @ad<"20021004"	US-PGPUB; USPAT	OR	ON	2005/03/11 12:08
L14	90	13 not 4	US-PGPUB; USPAT	OR	ON	2005/03/11 12:21
L15	10	(("6104835") or ("6233719") or ("5991699") or ("5208648") or ("5220403") or ("4599558") or ("5644393") or ("4618938") or ("4556317") or ("5563702")).PN.	US-PGPUB; USPAT	OR	OFF	2005/03/11 12:28
L16	1	("20030139838").PN.	US-PGPUB; USPAT	OR	OFF	2005/03/11 12:28

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	807	(wafer or substrate) and (inspect or inspection or inspecting) and Tencor	US-PGPUB; USPAT	OR	ON	2005/03/11 14:05
L2	95	1 and (front adj (surface or side))	US-PGPUB; USPAT	OR	ON	2005/03/11 14:05
L3	74	2 and (back adj (surface or side))	US-PGPUB; USPAT	OR	ON	2005/03/11 14:06
L4	55	3 and @ad<"20021004"	US-PGPUB; USPAT	OR	ON	2005/03/11 14:20
L5	1	("5166516").PN.	US-PGPUB; USPAT	OR	OFF	2005/03/11 14:20

US-PAT-NO: 6829559

DOCUMENT-IDENTIFIER: US 6829559 B2

TITLE: Methods and systems for determining a presence of macro and micro defects on a specimen

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Brief Summary Text - BSTX (118):

An embodiment relates to a system that may be configured to determine a presence of defects on multiple surfaces of a specimen. The system may include a stage configured to support the specimen. The system may also include a measurement device coupled to the stage. The stage may be configured to move. The measurement device may include an illumination system configured to direct energy toward a **front side and a back side** of the specimen. The illumination system may be used while the stage is stationary or moving. The measurement device may also include a detection system coupled to the illumination system. The detection system may be configured to detect energy propagating along multiple paths from the front and **back sides** of the specimen. The system may also include a processor coupled to the measurement device. The measurement device may be configured to generate one or more output signals in response to the detected light. The processor may be configured to determine a presence of defects on the front and **back sides** of the specimen from the one or more output signals.

Brief Summary Text - BSTX (120):

In an embodiment, the processor may include a local processor coupled to the measurement device and a remote controller computer coupled to the local processor. The local processor may be configured to at least partially process the one or more output signals. The remote controller computer may be configured to receive the at least partially processed one or more output signals from the processor. In addition, the remote controller computer may be configured to determine a presence of defects on the front and **back sides** of the specimen from the at least partially processed one or more output signals. Furthermore, the remote controller computer may be configured to determine additional properties of the specimen from the at least partially processed one or more output signals. In an additional embodiment, the remote controller computer may be coupled to a process tool such as a semiconductor fabrication process tool. In this manner, the remote controller computer may be further configured to alter a parameter of one or more instruments coupled to the process tool in response to at least the determined first or second property of the specimen using an in situ control technique, a feedback control technique, and/or a feedforward control technique.

Brief Summary Text - BSTX (121):
An additional embodiment relates to a method for determining defects on multiple surfaces of a specimen. The method may include disposing a specimen upon a stage. The stage may be coupled to a measurement device. The measurement device may include an illumination system and a detection system. In addition, the method may include directing energy toward a **front side and a back side** of the specimen using the illumination system. The method may also include detecting energy propagating along multiple paths from the front and **back sides** of the specimen using the detection system. The method may further include generating one or more output signals in response to the detected energy. Furthermore, the method may include processing the one or more output signals to determine the presence of defects on the front and **back sides** of the specimen.

Detailed Description Text - DETX (61):
As used herein, the terms "**front side" and "back side**" generally refer to opposite sides of a specimen. For example, the term, a "**front side**", or "upper surface," of a specimen such as a wafer may be used to refer to a surface of the wafer upon which semiconductor devices may be formed. Likewise, the term, a "**back side**", or a "bottom surface," of a specimen such as a wafer may be used to refer to a surface of the wafer which is substantially free of semiconductor devices.

Detailed Description Text - DETX (62):
System 32 may include stage 42 configured to support specimen 40. As shown in FIG. 12, stage 42 may contact a **back side** of the specimen proximate to an outer lateral edge of the specimen to support the specimen. For example, the stage may include a robotic wafer handler configured to support a specimen. In alternative embodiments, an upper surface of the stage may be configured to have a surface area less than a surface area of the **back side** of the specimen. In this manner, stage 42 may contact a **back side** of the specimen proximate to a center, or an inner surface area, of the specimen to support the specimen. In an example, the stage may include a vacuum chuck or an electrostatic chuck. Such a stage may be disposed within a process chamber of a process tool such as a semiconductor fabrication process tool and may be configured to support the specimen during a process step such as a semiconductor fabrication process step. Such a stage may also be included in any of the other measurement

devices as described herein.

Detailed Description Text - DETX (63):
System 32 may include a measurement device coupled to the stage. The measurement device may include a plurality of energy sources 44. A first of the plurality of energy sources 44 may be configured to direct energy toward **front side** 40a of specimen 40. As shown in FIG. 12, two detectors 46a and 46b may be coupled to the first of the plurality of energy sources. The two detectors may be positioned at different angles with respect to the first energy source. In this manner, each of the detectors may be configured to detect different types of energy propagating from **front side** 40a of specimen 40. For example, detectors 46b may be configured to detect dark field light propagating from the **front side** of specimen 40. In addition, detector 46a may be configured to detect bright field light propagating from the **front side** of specimen 40. In an alternative embodiment, however, a single detector, either detector 46a or detector 46b,may be included in the measurement device and may be coupled to the first energy source. Additional components such as component 48 may also be coupled to the first energy source. For example, component 48 may include any of the optical components as described herein.

Detailed Description Text - DETX (65):
In an embodiment, a second of the plurality of energy sources 44 may be configured to direct energy toward **back side** 40b of specimen 40. The measurement device may also include detector 46c coupled to the second energy source. In addition, multiple detectors may be coupled to the second energy source. Detector 46c may be positioned with respect to the second energy source such that a particular type of energy propagating from **back side** 40b of specimen 40 may be detected. For example, detector 46c may be positioned with respect to the second energy source such that dark field light propagating along a dark field path from the **back side** 40b of specimen 40 may be detected. Additional component 48 may also be coupled to the second energy source. Component 48 may include any of the optical components as described herein. Furthermore, system 32 may include processor 54. Processor 54 may be coupled to each of the detectors 46a, 46b, and 46c, as shown in FIG. 12. The processor may be configured as described herein.

Detailed Description Text - DETX (66):
According to the above embodiment, therefore, system 32 may be configured to determine at least two properties on at least two surfaces of a specimen. For example, system 32 may be configured to determine a presence of defects on a **front side** of the specimen. In addition, system 32 may be configured to determine a presence of defects on a **back side** of the specimen. Furthermore,

the system may be configured to determine a presence of defects on an additional surface of the specimen. For example, the system may be configured to determine a presence of defects on a **front side, a back side,** and an edge of the specimen. As used herein, the term "an edge" of a specimen generally refers to an outer lateral surface of the specimen substantially normal to the front and **back sides** of the specimen. Furthermore, the system may also be configured to determine a presence of defects on more than one surface of the specimen simultaneously.

Detailed Description Text - DETX (70):

Micro defects may typically have a lateral dimension of less than approximately 25 .mu.m. Macro defects may include yield-limiting large scale defects having a lateral dimension of greater than about 25 .mu.m. Such large scale defects may include resist or developer problems such as lifting resist, thin resist, extra photoresist coverage, incomplete or missing resist, which may be caused by clogged dispense nozzles or an incorrect process sequence, and developer or water spots. Additional examples of macro defects may include regions of defocus ("hot spots"), reticle errors such as tilted reticles or incorrectly selected reticles, scratches, pattern integrity problems such as over or under developing of the resist, contamination such as particles or fibers, and non-uniform or incomplete edge bead removal ("EBR"). The term "hot spots" generally refers to a photoresist exposure defect that may be caused, for example, by a depth of focus limitation of an exposure tool, an exposure tool malfunction, a non-planar surface of a specimen at the time of exposure, foreign material on a **back side** of a specimen or on a surface of a supporting device, or a design constraint. For example, foreign material on the **back side** of the specimen or on the surface of a supporting device may effectively deform the specimen. Such deformation of the specimen may cause a non-uniform focal surface during an exposure process. In addition, such a non-uniform focal surface may be manifested on the specimen as an unwanted or missing pattern feature change.

Detailed Description Text - DETX (125):

In an embodiment, the method may include processing the detected energy to determine a third property of the specimen. A third property of the specimen may include, but is not limited to, a presence, a number, a location, and/or a type of defects on the surface of the specimen and a flatness measurement of the specimen. The defects may include macro defects and/or micro defects as described herein. In addition, the method may include processing the detected energy to determine a third property and a fourth property of a specimen. For example, the third property may include a presence, a number, a location, and/or a type of defects on the surface of the specimen, and the fourth property may include a flatness measurement of the specimen. As such, the method may be used to determine a critical dimension, an overlay misregistration, a presence, a number, a location, and/or a type of defects on the specimen, and a flatness measurement of the specimen. The method may include determining such properties of a specimen sequentially or substantially simultaneously. In an additional embodiment, the method may include directing energy toward a **front side** and/or a **back side** of a specimen. As such, the method may also include detecting energy propagating from the **front side** and/or the **back side** of the specimen, respectively. In this manner, the method may also include determining a presence, a number, a location, and/or a type of defects on a **back side** of the specimen. The defects may include macro defects.

Detailed Description Text - DETX (148):

In an additional embodiment, the method may also include processing the detected energy to determine a third property of the specimen. For example, the third property may include a presence of defects on a surface of the specimen. The third property may also include a number, a location, and/or a type of defects on a surface of the specimen. The defects may include micro defects, macro defects, or micro and macro defects. In an embodiment, the method may also include controlling the illumination system to direct energy toward a **back side** of the specimen. The method may further include controlling the detection system to detect energy propagating from the **back side** of the specimen. As such, the third property of the specimen may also include a presence of defects on the **back side** of the specimen. Such defects may include macro defects. In addition, a third property may also include a flatness measurement of the specimen. In an additional embodiment, the method may also include processing the detected light to determine a third and a fourth property of the specimen. In this manner, the third and fourth properties may include, but are not limited to, a presence, a number, a location, and/or a type of defects on a surface of the specimen and a flatness measurement of the specimen. In addition, the method may include determining at least two of the properties substantially simultaneously. The method, however, may also include determining all four of the properties described above sequentially or substantially simultaneously.

Detailed Description Text - DETX (154):

An embodiment relates to a system which may be configured to determine at least two properties of a specimen, which may include a presence of defects on the specimen and a thin film characteristic of the specimen. For example, a presence of defects may be determined on a **front side or a back side** of a specimen as described herein. The defects may also include subsurface defects and/or a presence of macro defects on a backside of a specimen, which may include copper contamination and/or resist contamination. In addition, the thin film characteristic may include a thickness of a film such as copper. The system may be configured as described herein. In addition, the processor of such a system may be configured to determine additional properties of the specimen from energy detected by a measurement device. In an embodiment, the measurement device may be configured as a non-imaging scatterometer, a scatterometer, a spectroscopic scatterometer, a reflectometer, a spectroscopic reflectometer, an ellipsometer, a spectroscopic ellipsometer, a bright field imaging device, a dark field imaging device, a bright field and dark field imaging device, a bright field non-imaging device, a dark field non-imaging device, a bright field and dark field non-imaging device, a double dark field device, a coherence probe microscope, an interference microscope, an optical profilometer, a dual beam spectrophotometer, a beam profile ellipsometer, or any combination thereof. In this manner, the measurement device may be configured to function as a single measurement device or as multiple measurement devices. Because multiple measurement devices may be integrated into a single measurement device of the system, optical elements of a first measurement device, for example, may also be optical elements of a second measurement device. Such a system may be coupled to a chemical-mechanical polishing tool, a deposition tool, an etch tool, a cleaning tool such as a wet or dry stripping tool, or a thermal tool such as a furnace configured to perform rapid thermal processing ("RTP") of a specimen as described herein. Examples of cleaning tools are illustrated in PCT Application No. WO 00/17907 and "Chemically Assisted Laser Removal of Photoresist and Particles from Semiconductor Wafers," by Genut et al. of Oramir Semiconductor Equipment Ltd., Israel, presented at the 28.sup.th Annual Meeting of the Fine Particle Society, Apr. 1-3, 1998, which are incorporated by reference as if fully set forth herein.

Detailed Description Text - DETX (161):

FIG. 22 illustrates an embodiment of a system configured to determine at least two properties of a specimen coupled to chemical-mechanical polishing tool 222. Chemical-mechanical polishing ("CMP") may typically be used in the semiconductor industry to partially remove or planarize a layer on a specimen. Chemical-mechanical polishing may include holding and/or rotating a specimen against a rotating polishing platen under controlled pressure. Chemical-mechanical polishing tool 222 may include polishing head 224 configured to hold specimen 226 against polishing platen 228. Polishing head 224 may include a number of springs 230 or another suitable mechanical device, which may be configured to apply an adjustable pressure to a **back side** of specimen 226. Polishing head 224 may also be configured to rotate around a central axis of the polishing head. In addition, polishing head 224 may also be configured to move linearly with respect to the polishing platen.

Detailed Description Text - DETX (170):
In an embodiment, a system configured to determine at least a presence of defects of a specimen and a critical dimension of the specimen may be coupled to an etch tool as described herein. The presence of defects may include a presence of defects on a **back side** of the specimen. In addition, the system may be further configured to determine a number, a location, and/or a type of defects on the specimen. The system may be coupled to the etch tool such that at least a presence of defects on the specimen and a critical dimension of the specimen may be determined prior to and subsequent to an etch process or a step of an etch process. As described herein, at least one of the determined properties may be used to alter a parameter of one or more instruments coupled to a process tool. For example, a determined critical dimension of the specimen may be used to alter a parameter of one or more instruments coupled to a lithography tool using a feedforward control technique or a feedback control technique. In addition, a determined presence of defects on the specimen may be used to alter a parameter of one or more instruments coupled to the lithography tool using a feedforward control technique or a feedback control technique.

Detailed Description Text - DETX (181):
In an embodiment, a system may be configured to determine at least two properties of a specimen including a presence of macro defects on at least one surface of the specimen and overlay misregistration of the specimen. The determined properties may also include a number, a location, and a type of macro defects present on at least one surface of the specimen. At least one surface of the specimen may include a **back side** and/or a **front side** of the specimen. The system may be configured as described herein. For example, the system may include a processor coupled to a measurement device. The processor may be configured to determine at least a presence of macro defects and overlay misregistration of the specimen from one or more output signals generated by the measurement device. In addition, the processor may be configured to determine other properties such as a critical dimension of a feature on the specimen from the one or more output signals. In an embodiment, the measurement device may include a scatterometer, a non-imaging scatterometer, a spectroscopic scatterometer, a reflectometer, a spectroscopic reflectometer, an ellipsometer, a spectroscopic ellipsometer, a beam profile ellipsometer, a bright field imaging device, a dark field imaging device, a bright field and dark field imaging device, a bright field non-imaging device, a dark field non-imaging device, a bright field and dark field non-imaging device, a coherence probe microscope, an interference microscope, an optical

profilometer, or any combination thereof.

Detailed Description Text - DETX (184):
In addition, a parameter of one or more instruments coupled to a process tool may be altered in response to the properties determined by the system using a feedback control technique, an in situ control technique, and/or a feedforward control technique. For example, a presence of macro defects on the surface such as a presence of macro defects on a **back side** of a specimen determined by the system prior to, during, and/or subsequent to an etch process, a deposition process, and/or a chemical-mechanical process may be used to alter a parameter of one or more instruments coupled to a lithography tool using a feedforward control technique. In this example, the determined presence of macro defects on the **back side** of the specimen may be used to alter a dose and focus condition of an exposure tool during exposure of the specimen during a lithography process. In an additional example, overlay misregistration of a specimen determined by the system prior to, during, and/or subsequent to an etch process and/or a deposition process may be used to alter a parameter of one or more instruments coupled to a lithography tool using a feedforward control technique. In this example, the determined overlay misregistration may be used to alter a lateral alignment of a reticle in an exposure tool during exposure of the specimen during a lithography process.

Detailed Description Text - DETX (238):
FIG. 23 illustrates an embodiment of a system configured to evaluate a deposition process. In an embodiment, a system may include measurement device 238 coupled to deposition tool 240. Measurement device 238 may be coupled to deposition tool 240 such that the measurement device may be external to a process chamber of the deposition tool. As such, exposure of the measurement device to chemical and physical conditions within the process chamber may be reduced, and even eliminated. Furthermore, the measurement device may be externally coupled to the process chamber such that the measurement device may not alter operation, performance, or control of the deposition process. For example, a process chamber may include relatively small sections of a substantially optically transparent material 242 disposed within walls of the process chamber. The configuration of a deposition tool, however, may determine an appropriate method to couple the measurement device to the deposition tool. For example, placement and dimensions of substantially optically transparent material sections 242 disposed within the walls of the process chamber may vary depending on, for example, the arrangement of the components within the process chamber. In addition, measurement device 238 may be coupled external to the process chamber such that the measurement device may direct energy to a surface of the specimen and may detect energy returned from

a surface of the specimen as a specimen is being placed within and/or being removed from the process chamber. A surface of the specimen may include a **front side** of the specimen or a **back side** of the specimen.

Detailed Description Text - DETX (263):
Process conditions of a subsequent polishing process, however, may be optimized for the predetermined thickness of the deposited layer on the specimen. Therefore, before polishing the deposited layer, a parameter of one or more instruments coupled to a polishing tool such as process time or pressure applied to a **back side** of the specimen may be altered such that an upper surface of the deposited layer may be planarized. For example, a process time may be increased to ensure substantially complete planarization of the deposited layer. In this manner, the processor may be configured to alter a parameter of an instrument coupled to a chemical mechanical polishing tool in response to one or more output signals from the measurement device using a feedforward control technique. In addition, the processor and the measurement device may be further configured according to any of the embodiments described herein. For example, a processor coupled to the measurement device may also be configured to detect defects on the specimen, a thickness of a deposited material, a sheet resistivity of a deposited material, a thermal diffusivity of a deposited material, or any combination thereof during the deposition process using one or more output signals from the measurement device.

Detailed Description Text - DETX (348):
In an embodiment, processor 364 coupled to measurement device 346 may be configured to determine one or more characteristics of defects on a surface of specimen 352, as shown in FIG. 26. In addition, processor 378 coupled to measurement device 365 may be configured to determine one or more characteristics of defects on one or more surfaces of specimen 370. Processor 364 and processor 378 may be similarly configured. For example, processors 364 and 378 may be configured to receive one or more output signals from detectors 360 and 362 or 366 and 376, respectively, in response to light detected by the detectors. In addition, both processors may be configured to determine at least one characteristic of defects on at least one surface of a specimen. The defects may include macro defects and/or micro defects. For example, processor 264 and processor 378 may be configured to determine at least one characteristic of macro defects on a **front side and a back side** of a specimen. In addition, one or more characteristics of defects may include, but are not limited to, a presence of defects on a surface of specimen, a type of defects on a surface of a specimen, a number of defects on a surface of a specimen, and a location of defects on a surface of a specimen. In addition, processor 364 and processor 378 may be configured to determine one or more characteristics of

defects substantially simultaneously or sequentially. In this manner, further description of processor 364 may be applied equally to processor 378.

Claims Text - CLTX (26):

26. The system of claim 1, wherein the macro defects comprise copper contamination on a **back side** of the specimen.